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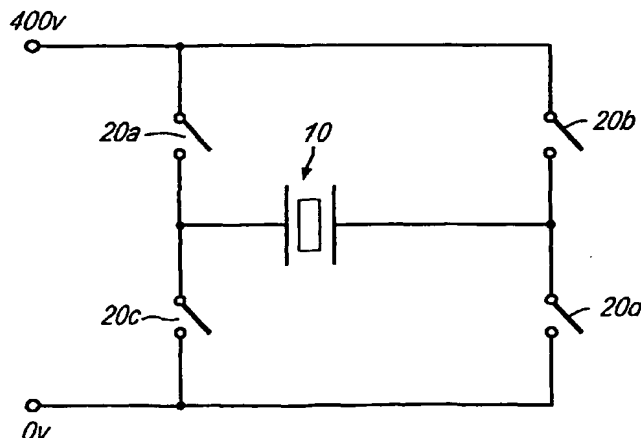
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(54) Title: DRIVE CIRCUIT FOR PIEZO CERAMIC DEVICE



(57) Abstract: A control circuit for controlling the operation of a piezo ceramic actuator comprising means for applying a voltage to the piezo ceramic actuator, the means arranged such that a linear charge is applied to the piezo ceramic device (10) which in turn produces a linear displacement of the piezo ceramic device. The control circuit preferably comprises four transistor switches (20) in H-bridge configuration.

INTERNATIONAL SEARCH REPORT

Int'l Application No

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A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 H01L41/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 H01L H02N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PALIS F ET AL: "Vibration damping using current fed piezoelectric actuators" 8TH EUROPEAN CONFERENCE ON POWER ELECTRONICS AND APPLICATIONS, EPE'99, LAUSANNE, SWITZERLAND, 7 - 9 September 1999, pages 1-6, XP000883032 section 2. "Modelling of piezoelectric actuators" section 3. "Controlling of piezoelectric actuators"	1-4,7
X	DE 198 10 321 A (UNIVERSITÄT MAGDEBURG; PALIS FRANK) 16 September 1999 (1999-09-16) column 2, line 14 -column 4, line 16; figure 4 --- -/--	1-4,7

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 001 474 A (STMICROELECTRONICS SRL) 17 May 2000 (2000-05-17) paragraph '0020! - paragraph '0031!; figure 2 ----	1,7
A	JP 2001 086778 A (MINOLTA CO LTD) 30 March 2001 (2001-03-30) -& US 6 566 790 B1 (SERITA YASUAKI) 20 May 2003 (2003-05-20) column 8, line 43 -column 12, line 47; figures 5,6 column 14, line 63 -column 15, line 46; figure 11 ----	1-7
A	EP 0 147 112 A (NIPPON TELEGRAPH & TELEPHONE CORP) 3 July 1985 (1985-07-03) page 9, line 18 -page 22, line 16; figure 1 ----	1-5,7
P,X	WEAVER P M ET AL: "Extended-temperature-range piezoactuator system with very large movement" SMART STRUCTURES AND MATERIALS 2003. ACTIVE MATERIALS: BEHAVIOUR AND MECHANICS, SAN DIEGO, CA, USA, 3-6 MARCH 2003, vol. 5053, pages 484-492, XP009021109 Proceedings of the SPIE ISSN: 0277-786X section 5. "Control system for extended temperature range operation" -----	1-3,5-7

INTERNATIONAL SEARCH REPORT

Int. Application No.

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 19810321	A	16-09-1999	DE	19810321 A1	16-09-1999
EP 1001474	A	17-05-2000	EP	1001474 A1	17-05-2000
			US	6246152 B1	12-06-2001
JP 2001086778	A	30-03-2001	US	6566790 B1	20-05-2003
EP 0147112	A	03-07-1985	JP	60190177 A	27-09-1985
			JP	1854155 C	07-07-1994
			JP	5061873 B	07-09-1993
			JP	60219971 A	02-11-1985
			JP	60229189 A	14-11-1985
			JP	61001278 A	07-01-1986
			JP	61030974 A	13-02-1986
			JP	61045389 A	05-03-1986
			JP	60123993 A	02-07-1985
			JP	1684750 C	31-07-1992
			JP	3050511 B	01-08-1991
			JP	61135368 A	23-06-1986
			CA	1225694 A1	18-08-1987
			DE	3485851 D1	03-09-1992
			DE	3485851 T2	18-03-1993
			EP	0147112 A2	03-07-1985
			US	4625137 A	25-11-1986
			KR	8903388 B1	19-09-1989